* satire on scientific male attitudes!

# Loving lizards: Sex and unisex species

Courtship and mating behaviors may be more widespread than the mixing of genes by sexual reproduction. "We report for the first time evidence indicating that although unisexual *Cnemidophorus* lizards have dispensed with genetic sex, behavioral sex continues," says David Crews of Harvard University.

At least 27 species of reptiles are made up entirely or almost entirely of females reproducing parthenogenetically, so that each daughter is genetically identical to her mother. Scientists collected members of three such lizard species from Arizona and Colorado and found that pairs of females of these species (but not of closely related sexual species) behave in a manner resembling mating.

The "sexual" behavior of the parthenogenetic females includes courtship and copulatory phases. One animal lunges at another and bites her on the tail, then mounts the back and rides atop for a minute or two, while stroking the back and neck with her jaws and forelimbs and rubbing her cloaca (the female lizard's combined reproductive and excretory opening) against the back. The top lizard grasps the back of the neck or shoulder in her jaws and curves her tail beneath the other's tail to appose the cloacal regions. Finally she shifts her jaw grip further down the body to achieve the contorted mating posture characteristic of that genus of lizard. The females maintain the position 1 to 5 minutes, until the bottom animal breaks away.

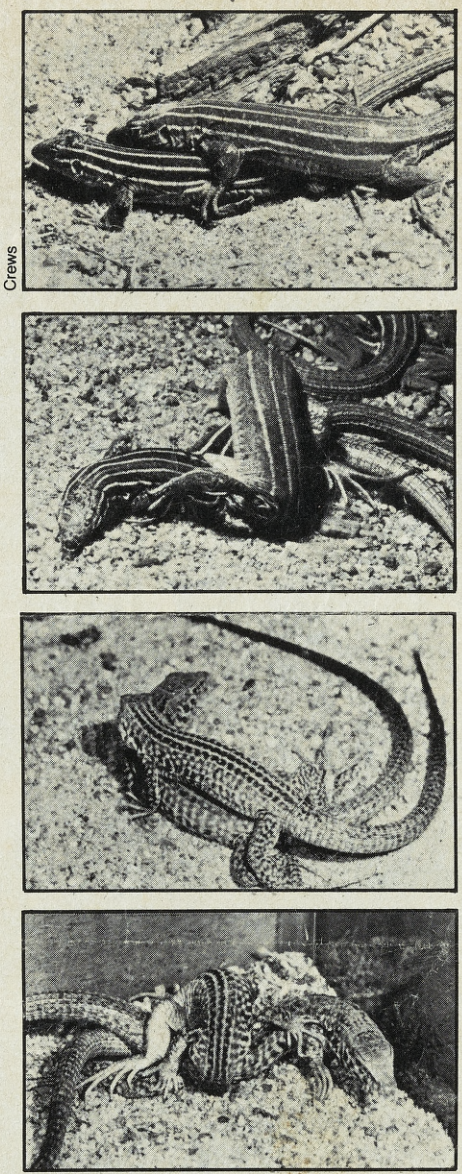
Age and size do not determine the lizards' sexual role. Which female is top and which is bottom is a matter of the ovulatory cycle, Crews and Kevin T. Fitzgerald of the University of Colorado find. In each of 17 pseudo-matings, the more aggressive, courting animal contained only small, undeveloped follicles in her ovaries and was either post-ovulatory or reproductively inactive. The more passive member of the pair always had large, yolky preovulatory follicles, and laid her eggs about 30 days later. Crews and Fitzgerald have seen the same lizard play both sexual roles.

The scientists do not yet know what makes the preovulatory female sexually attractive. Estrogen administered to females at other stages of their cycle does not make them attractive, although the allure may come from an estrogen-progesterone interaction. Crews suspects that chemicals emitted by the preovulatory female play a role, because the lizards have scent pores along their hind legs and inspect each other with much tongue-flicking activity.

The courting behavior seems to be more than a nonfunctional vestige of the lizard species' sexual ancestry. Crews says the behavior primes some hormonal mechanism that regulates the ovaries' activity. Animals caged alone do reproduce, but they lay eggs at longer intervals than do animals raised in groups.

So far the scientists have no idea of the ecological significance of the sexual behavior. The lizards live in large groups in burrows and are fast-moving. "In the wild, we never saw anything other than biting and chasing. We don't know what's going on in those tunnels," Crews says.

In current work, Crews and collaborators are treating the eggs of parthenogenetic lizards with hormones to try to create males. Crews says that they have already had some success in that the gonads of hatchlings of some treated eggs have a male-like duct system. "This could be the most dramatic research," Crews says. In essence they may be turning their lizards from parthenogenesis back to two-sex reproduction. □



Crews

*Mounting and contorted mating posture of all-female* Cnemidophorus uniparens *(upper photos) closely resemble those of sexual species* C. tigris *(lower photos).*

# Ozone depletion: Death to shellfish?

While the earth is expected to lose an estimated 16.5 percent of its ozone layer over the next 100 years (SN: 11/17/79, p. 340), it appears that *current* stratospheric ozone levels may already be dangerously close to damaging certain marine life environments. Scientists at the National Marine Fisheries Laboratory in Manchester, Wash., report that above a certain "threshold level" of exposure to ultraviolet radiation, the survival rates of shrimp and crab larvae decline rapidly.

The experimental threshold of UV-B — the middle portion of the ultraviolet spectrum that is partially filtered out by the ozone — is near the levels that shellfish already experience in their natural environment, according to David Damkaer of the fisheries lab, which is part of the National Oceanic and Atmospheric Administration. Shrimp and crab larvae already are "living close to the thin edge of survival," Damkaer says.

The shellfish larvae generally inhabit ocean surface waters in the late winter and early spring. Although the UV-B radiation reaches its peak in July — when it exceeds the tolerance level determined in the study — NOAA scientists note that UV-B levels are close to or above the danger threshold by the end of the surface season of each species. The effect of ozone depletion, Damkaer and his colleagues suggest, would be to admit more UV-B earlier in the season, shortening the creatures' "safe" time in surface waters.

"Whether or not the populations could endure with a drastically reduced time of near-surface occurrence is not known," Damkaer says. "The way things look, if ultraviolet increases, we're going to see the populations of some species die out. This is serious. And it's dollars and cents to the fishermen of this state and anywhere else where the environment might become inhospitable to shellfish." □

# Hopkins heart disease advances

What biomedical advances can a specific amount of money buy? One answer to this rarely posed but eminently practical question was given last week at a science writers' conference at the Johns Hopkins Medical Institutions in Baltimore. Investigators in John Hopkins's cardiology division described some recent advances they have made with $8 million in government and university funds.

• Several years ago Duke University researchers invented two-dimensional ultrasound, which uses high-frequency, pulsed sound to display several areas of

*Continued on page 430*



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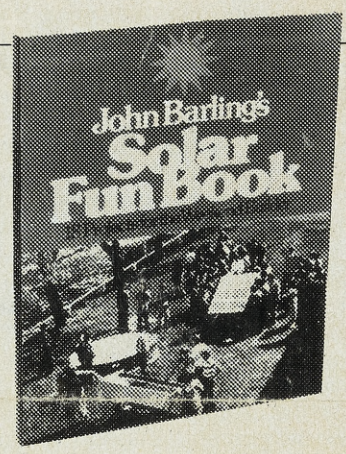
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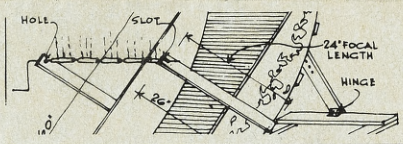
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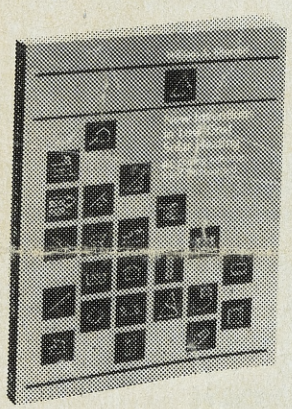

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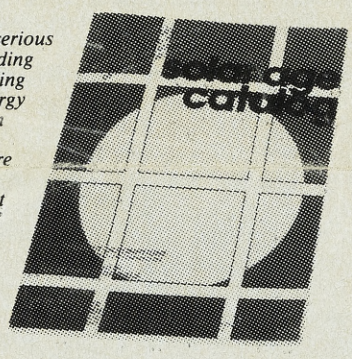


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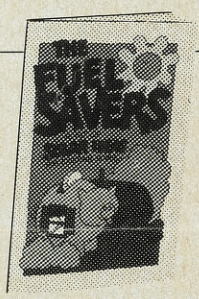

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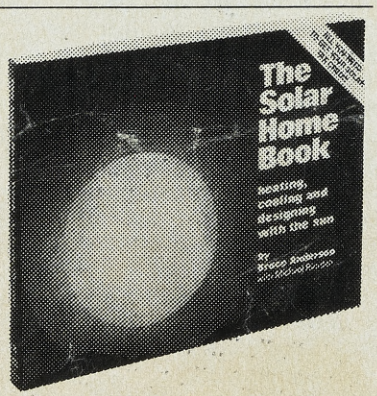
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# The brain's behind evolution's drive

The constantly changing earth puts pressure on all living species to evolve to take best advantage of their environment. But an additional factor — behavior — overshadows this external force in evolution of higher vertebrates, a biologist now proposes.

"The brain drives evolution," says Allan C. Wilson of the University of California at Berkeley. "Even in an environment that isn't changing, organisms with big brains find new ways of exploiting the environment," he told science writers this week at a meeting at the Cold Spring Harbor Laboratories in Cold Spring Harbor, New York. In human evolution, behavior may underlie 99 percent of the anatomical change, he says.

Wilson arrived at his hypothesis of "behavioral drive" from consideration of the rapid anatomical changes that have taken place in the evolution of humans and apes, and to a lesser extent in other mammals and birds, in contrast to lizards, frogs and salamanders. The rate of change in the DNA of all these animals is approximately the same.

The crucial difference between rapidly evolving mammals and birds and the more conservative reptiles and amphibians is the power of their brains, Wilson suggests. The brain is especially big, in relation to body weight, in humans, apes and songbirds, groups whose rates of anatomical evolution are particularly high, according to evidence Wilson, Joseph G. Kunkel and Jeff S. Wyles present in the July PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (Number 14).

How can the brain drive evolution? Wilson proposes that an individual invents a behavior, which others then acquire by social, rather than genetic, means. For example, animals may observe and imitate others who perform a novel task. It is likely that some animals in a widespread population possess genetic mutations that make them more efficient than others in the new behavior. Thus the brain has provided a new set of selective pressures.

British songbirds who open bottles and drink the milk inside are an example of behavioral innovation and social transmission, Wilson says. A few of the birds, called tits, initiated the behavior and within decades most of Britain's million tits engaged in the practice.

In human evolution, Wilson points to the domestication of cattle and consequent milk consumption by adults, a behavior begun about 10,000 years ago in Northern European and some African populations. This habit may have produced selection pressure resulting in establishment in these populations of a gene for an enzyme that breaks down lactose (a sugar in milk) in the adult intestine.

Earlier views recognized that new behaviors produce selective pressures favoring complementary anatomical mutations. But Wilson says that there has not been an explicit hypothesis emphasizing the idea that nongenetic propagation of new skills in large populations will significantly accelerate anatomical evolution in vertebrates other than humans.

"If it was not explicitly formulated, it is implicit in work on cultural evolution," argues Stephen J. Gould of Harvard University. He says interaction of biological and cultural evolution is a familiar theme in anthropology.

"People have sent up trial balloons on this subject for many years," says Clayton E. Ray of the Smithsonian's Museum of Natural History in Washington. "The problem is, how do you get a handle on demonstrating it? Rates of anatomical evolution are very difficult to quantify."

Wilson and colleagues measure rates of anatomical change by comparing eight traits, such as head width and backbone length, originally chosen to discriminate among frogs. They find a composite morphological, or anatomical, distance between groups of animals that correlates with their distance in taxonomic classification. There is on the average the least morphological distance between members of a subspecies, and the distance increases with larger groupings going up to orders.

"This is a very simple method for evaluating anatomical differences," says Luigi L. Cavalli-Sforza of Stanford University in Stanford, Calif. "I am a little worried about what it leaves out, but as a first approximation it's not bad."

Wilson's hypothesis of behavioral selection applied to birds and mammals seems both reasonable and novel, Cavalli-Sforza says. "It is not easy to eliminate other hypotheses, but it's interesting as an idea."

*—J.A. Miller*

# Who's the ancestral mother of modern man?

Biologists, studying DNA differences in individuals around the world, have now traced human lineage back to a common female ancestor. But they don't agree on who she was and when she lived. "We all go back to one mother living 350,000 years ago," says Allan C. Wilson of the University of California at Berkeley. Because this date is believed to fall in the transition period from *Homo erectus* to the current *Homo sapien* form, "she [the common ancestress] preceded our species," Wilson told science writers this week at a meeting at Cold Spring Harbor (N.Y.) Laboratory.

But another group of scientists using similar methods, also unpublished, has evidence that the shared predecessor of modern man was more recent; living only 50,000 to 100,000 years ago. This date, calculated by his research team, is more in agreement with those dates derived from other genetic approaches and fossil examination, Luigi L. Cavalli-Sforza of Stanford University said in a telephone interview.

The DNA samples examined by Wilson and by Cavalli-Sforza were taken from mitochondria, the power-producing structures of cells. These structures in the cell cytoplasm contain 35 genes that are passed directly from mother to offspring. Because sperm contribute no mitochondria to an embryo, there is no mixing of maternal and paternal DNA. The only changes in mitochondrial DNA are mutations that arise spontaneously with time, and thus should be easy to evaluate. These mutations alter about 2 percent of the mitochondrial DNA in a million years, according to experiments on rodents, horses and monkeys, Wilson says.

Wilson found 110 variations in the mitochondrial DNA of 112 individuals in a worldwide survey. (Last year he and colleagues found no variation among common strains of laboratory mice thought to be unrelated, and thus concluded these mice share a recent female ancestor [SN: 1/30/82, p. 71]). He constructed a human pedigree by finding the simplest pattern of changes to explain the differences observed. Exactly why Wilson's date for the common ancestress differs so greatly from Cavalli-Sforza's is unclear.

A somewhat surprising characteristic of Wilson's pedigree of the human race is that groups of closely related mitochondrial DNA include samples taken from individuals with different racial heritages. And individuals originating on a single continent, even one as remote as Australia, appear to have been founded by two or more mothers, not closely related. Some Australian aborigines, by this analysis, are more closely related to some Asians and Africans than to the other Australian aborigines sampled. Wilson comments on the pedigree, "You don't see race staring at you. There is racial intermingling mitochondrially."

To substantiate the accuracy of such an approach to evolution, scientists might examine some population known to derive from a single woman, but Wilson says it is difficult to find such a group. He and colleagues plan next to concentrate on people of European descent, especially the Jewish population where there are extensive historical records.

Meanwhile, examination of mitochondrial DNA is regarded generally as an intriguing but uncertain approach to human evolution. T. Dale Stewart of the Smithsonian's Museum of Natural History comments, "It's a pretty tricky business at this point." And Cavalli-Sforza says, "This method is a little more chancy than others. Mitochondria may have surprises in store."

*—J.A. Miller*

# Genes shed light on photosynthesis

What drives life, according to Nobel laureate Albert Szent-Györgyi, is "a little current, kept up by the sunshine." While scientists have known the mechanism of this current for years, they are just beginning to understand its genetic basis. In a discovery that could elucidate the evolution of higher plants and the action of herbicides, University of California scientists have isolated and sequenced five genes that control the first steps of photosynthesis in bacteria.

John E. Hearst of UC's Lawrence Berkeley Laboratory (LBL), in Berkeley, announced the findings at the Sixth International Congress on Photosynthesis in Brussels, Belgium on Aug. 3, 1983. In addition to being the first to sequence genes of the intitial reactions of bacterial photosynthesis, the LBL team demonstrated that a protein coded for by one of the genes matches one of similar function in spinach and tobacco. According to Hearst, this could mean that nature conserved genetic information for the three billion years that are believed to separate bacteria from higher plants on the evolutionary tree.

The team isolated the genes from *Rhodopseudomonas capsulata,* a purple bacterium found in the part of lakes that contains decaying organic material. In the presence of oxygen, the bacterium grows by respiration, breaking down organic compounds to produce carbon dioxide and water. But when oxygen levels fall, *R. capsulata* uses available sunlight to photosynthesize.

Photosynthesis consists of two steps. In the light reactions, pigment molecules, primarily chlorophyll, absorb and store light energy. In the dark reactions, energy obtained from the light reactions reduces carbon dioxide to carbohydrate.

Before *R. capsulata* can photosynthesize, it must assemble a reaction center that consists of photosynthetic pigments and associated proteins. A nearby light-harvesting area, also consisting of pigments and proteins, funnels photons to the reaction center, where they boost electrons to a higher energy level. The pigments in the reaction center are identical to those in the light-harvesting area; their associated proteins determine their role in photosynthesis.

The genes Hearst's team found code for three proteins that comprise the reaction center and two that participate in light-harvesting reactions. "These proteins bind with pigments, and therefore help determine their function," says Kris M. Zsebo, who helped locate the genes.

After sequencing the five genes and the proteins they code for, the LBL group compared them to a protein that binds pigments and aids in electron transfer in spinach and tobacco. A sequence from one of the bacterial proteins matches that of the plants. According to Zsebo, many herbicides work by binding to this protein, blocking its active site. "Studying bacterial genes," she says, "might aid in figuring out how herbicides work and how some plants develop resistance."

"The homology between bacteria and higher plants is also important in terms of evolution," says Helmut Bagusch, who participated in sequencing the genes. "We think there is only one [fundamental type of] photosynthesis, which means nature did it right the first time around."

According to the group, this finding also gives credence to the theory that chloroplasts, the photosynthetic cells of higher plants, originated as free-living photosynthetic bacteria that found shelter within larger cells in return for trapping light energy. —*S. Steinberg*

# Pinning a tail on a comet

Some comets have tails; some do not. At least that is true for visible tails. Now an invisible tail has been found on a comet. The comet is Tempel 2, which completes its elliptical orbit every 5.28 years and comes within the orbit of Mars on its perihelion passage. The tail, or most of it, radiates infrared and was found by the Infrared Astronomy Satellite (IRAS).

On July 13 IRAS noted what appeared to be a large number of objects moving in unison across the sky. Analysis of the data led to the determination by John Davies of the University of Leicester in England that the train of objects was linked to Tempel 2 and was in fact a long tail stretching over 10 degrees of sky. The tail is apparently composed of dust blown off the comet's nucleus by the solar wind. The sun heats the dust enough for it to glow in infrared. Tempel 2 is now on its way out from a perihelion passage on June 1.

Most short period comets do not have visible tails. Now the question is: How many comets without visible tails have invisible ones? Another question is: What is the dust in the tail made of? When the data analysis reveals some of its chemical composition, the tail will be even more interesting, says Dan Green of the Central Bureau for Astronomical Telegrams in Cambridge, Mass. It could be an important input into the problem of what comets are, where they come from and why they are associated with the solar system.

Efforts are underway to photograph the tail and to see if it shows up at all in visible light. In fact a small part of it already has been seen. Green says that a French observer, Jean-Claude Merlin of Le Creusot, has reported seeing a tail extending about four arcminutes from the comet, or 1/50 of the length of the infrared tail. —*D. E. Thomsen*

# Sand body hints new oil sources

All that's missing is the heat. On a recent cruise for the Deep Sea Drilling Project (DSDP), researchers found massive sand and sandstone beds, rich in organic material, 4,000 feet beneath the seafloor. Except for the lack of heat necessary to cook the organic matter and break it down into hydrocarbons, the setting is ideal, scientists say, for petroleum formation. The sand body is on the continental rise below waters far deeper than at any site drilled for petroleum to date. The scientific team suggests that "the continental rise off the eastern United States should be seriously evaluated as a petroleum province."

The oil industry generally has ignored the continental rise because no porous rock, such as sandstone, which serves as a reservoir for oil or gas, was thought to exist there. The discovery of the sand body was made on the 93rd leg of the DSDP at a site 270 miles east of Cape Hatteras, N.C. Another condition, rock to cap the sand and prevent the hydrocarbons from diffusing upward, also is present.

With the added impetus of heat or pressure, given sufficient time the conditions would be perfect for petroleum production, scientists report. On the continental rise closer to shore, deposits of hydrocarbons are more likely because sediment would be thicker, creating more pressure and thus more heat, says Philip A. Meyers of the University of Michigan in Ann Arbor. Land-derived organic matter also should be more abundant closer to shore. The DSDP cruise was led by co-chief scientists Jan Van Hinte of the Free University of Amsterdam, the Netherlands, and Sherwood W. Wise Jr., of Florida State University in Tallahassee.

The sands, interlaced with layers of black shale, were deposited about 115 million years ago during the early Cretaceous Period. Within the 700-foot-thick sand body, organic matter abounds. The shale in the sand body contains from 4.1 to 13.6 percent organic matter, the highest percentage found so far at any North Atlantic site. The deposit is capped by about 3,000 feet of impermeable shale. No mature hydrocarbons were found. The buried sand deposit is too shallow to allow enough pressure for the formation of oil or gas from the shale.

Scientists speculate that the sand may have come from large river deltas that fanned across the continental shelf and spilled over into the deep sea basin. It has been widely accepted that during the early Cretaceous, sea levels were rising, and that coral reefs provided a barrier along the mid-Atlantic coast, trapping sediment from the land in vast basins (shoreward from the DSDP site) on the continental shelf. The recent finding throws this assumption into question. —*C. Simon*